XII THE MUSCULOSKELETAL SYSTEM

HENCH AT THE MAYO CLINIC

After he received a Nobel Prize in 1950, Philip S. Hench commented, "At the Mayo Clinic no man works alone." On September 21, 1948, 7 days before he would depart for England to deliver the Heberden Oration, Hench and two colleagues, Howard F. Polley and Charles H. Slocumb, administered 100 mg of compound E, later named cortisone, to a young woman with rheumatoid arthritis. The events leading up to this breakthrough in medicine are as interesting as what followed, described below by Polley and Slocumb (1976):

> *By the evening of Sept. 23, our first patient felt better. Slocumb reported this to Hench, telling him that if the effects were sustained another 24 hours he must see the patient before he left Rochester. The next morning the anti-rheumatic changes were undeniably evident. Hench was very busy with final preparations for his departure, and only grudgingly did he agree to meet us at her hospital room at 7:30 p.m., Sept. 24. As he entered the doorway he exclaimed to her, "You're ruining my evening!" After he visited with her, however, it became apparent that she was "ruining" more than his evening. Now he was most reluctant to leave Rochester, especially because he was not to return for almost three months. . . .*
>
> *Conferences with Hench continued until his departure as we made plans for continuing and extending studies that now were clearly and urgently needed. Hench particularly wished to avoid premature publicity. The hopes of arthritic patients and their relatives were (and still are) understandably easy to arouse. All of us were well aware of what Hench frequently used to refer to as the "inevitable 65%"—that large percentage of favorable responses that seemed to occur, initially, with most therapies for rheumatoid arthritis. We all agreed to refer to compound E by the code name, "Substance H." ["H" was a letter common to all three clinicians' names.]*

The title of the Heberden Oration delivered by Hench was "The Potential Reversibility of Rheumatoid Arthritis," based on 19 years of astute clinical observation. In a reminiscence, Hench recalled his first interest in the subject in 1929, at age 33:

> *Rheumatoid arthritis was considered a relentless progressive disease. Therefore, I too was not optimistic when, on April 1, 1929, I went to see another rheumatoid patient. But he was different from any I had ever seen.*
>
> *For a long time, this patient's joints had been painful and swollen. Then one day yellow jaundice developed, and almost immediately the painful swelling began to disappear. When I saw him a few days later, he had practically no rheumatism.*
>
> *Thereafter, on the lookout for this phenomenon, I saw it happen fifteen more times during the next five years. Only one conclusion was possible. Contrary to the belief of centuries, rheumatoid arthritis must be potentially reversible, and rapidly so. (1953)*

Two years later, Hench observed that arthritic pain temporarily decreased in pregnant women, and he reasoned that a steroid hormone may be responsible, since the hormones are high in blood during pregnancy. Hench studied these two phenomena for the next 8 years, observing that allergic conditions, such as asthma, hay fever, and food sensitivity, were also lessened in the presence of jaundice or pregnancy. He concluded that the unknown factor was a steroid hormone, both antiallergic and antirheumatic, present in the blood during liver disease and pregnancy, and he attempted to define it:

> *In any event, I very much needed chemical help, and sought it from various colleagues, especially Edward C. Kendall, chief of the Division of Biochemistry. Prior to 1938, my conferences with Dr. Kendall were infrequent and casual. But thereafter he became my chief collaborator. As we tried on innumerable occasions between 1938 and 1948 to conjecture what might be the chemical nature of substance X, neither of us knew that he and his associates, working on the adrenocortical compound E in his laboratory a few yards away, were at the very moment trying to isolate, identify and synthesize substance X or a reasonable facsimile thereof. (1953)*

Their interests eventually focused on the adrenal cortex as the source of the unknown factor, one of six steroids designated A through F that Kendall isolated by 1940. Enough compound E for practical use was not prepared until 1948, however, when the first 100 mg dose was administered to a rheumatoid patient. Hench treated 14 bedridden arthritic patients with compound E over the next year and later filmed them running and jumping. Compound E was eventually named *cortisone*. Wrote Hench:

> *Dr. Kendall has reminded me of an expectant mother who is so preoccupied that she never gets around to choosing a name for her offspring. And so in the early days when I objected to using its chemical name (Can you blame me? I could hardly pronounce it.) and when I asked Dr. Kendall to suggest a permanent substitute for the nondefinitive term, "Compound E," he soon gave me, without enthusiasm, a piece of paper with the abbreviation "corsone" written on it. But he did not mind when I wrote underneath his suggestion my own amendment, "cortisone," and thus it was "baptized." (1953)*

In 1950 Hench, Kendall, and Tadeus Reichstein, a German scientist, were awarded a Nobel Prize "for their discoveries concerning the suprarenal cortex hormones, their structure and biological effects." Of cortisone, Hench wrote

that it must have an oxygen atom at position 11, without which it is not cortisone and with which it is "a thing of power."

—CHARLES STEWART ROBERTS

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158 An Overview of the Musculoskeletal System

STEPHEN B. MILLER

History

There are five cardinal symptoms of musculoskeletal disease (Table 158.1): pain, swelling, erythema (redness), warmth, and stiffness. *Pain* is the major symptom. "Aching" or "throbbing" are the words most often used by patients to describe musculoskeletal pain, in contrast to "crushing," "boring," or "sharp" with reference to ischemic, visceral, or neuropathic pain. Pain should also be characterized as to location, positional relationships, frequency, duration, and precipitating or relieving factors. The historical identification of *swelling, erythema,* and *warmth* is of great importance. *Stiffness* is a symptom unique to the musculoskeletal system. The predilection of stiffness for certain times of the day (e.g., upon awakening), its duration and location are points of considerable historical importance. The pattern of involvement should be ascertained: anatomic area, self-limited or progressive, migratory or stationary, effect of treatment modalities. The presence and degree of weakness or other neurologic deficits should be ascertained.

Physical Examination

The physical examination should be composed of a particular sequence or order that is used on every patient, thereby ensuring completeness. A useful sequence is: general inspection (posture, gait, symmetry); upper extremities, including temporomandibular and chest wall joints; spine and pelvis; and lower extremities (Table 158.2). A goniometer to measure joint angles and a tape measure are the only required instruments (Table 158.3).

General inspection begins by observing the patient in the standing position for postural abnormalities. Observe for erect stance and any abnormal curvature: kyphosis, lordosis or scoliosis. Have the patient walk toward and away from you.

The patient then sits on the examining table facing the examiner. Each joint is assessed for tenderness, swelling, erythema, deformity, or asymmetry (Chapter 164). Range of motion, pain with movement, effusion, crepitus, and stability are noted.

The *temporomandibular joint* (Chapter 163) is examined first, beginning proximally and working distally (Figure 158.1). Palpation is done with the mouth closed, then open.

The *shoulder joints* (Figures 158.2 and 158.3) and contiguous joints are now examined. Observe, palpate, and assess range of motion of these joints: glenohumeral, acromioclavicular, sternoclavicular, and costochondral. Also examine the gliding tissue space between the scapula and thorax, the shoulder capsule or rotator cuff, and the subacromial bursa. Range of motion is now checked as follows:

- *Forward flexion:* Normal is parallel to floor.
- *Arms over head pressed against the ears:* Normal is 180 degrees.
- *Shoulder adduction:* Normal is 90 degrees.
- *External rotation:* Touch back of neck.
- *Internal rotation:* Touch back pocket of opposite side.

Proximal musculature is evaluated for strength with the patient abducting both shoulders parallel to the floor and resisting the examiner's downward pressure.

The examiner moves now from the shoulders to the *elbows.* Examine the depth of the grooves; obliteration is a sign of synovial disease. Look for subcutaneous nodules just distal to the elbow joint. Evaluate range of motion: extension of zero degrees, flexion 160 degrees. Test the radiohumeral

Table 158.1
Major Symptoms of Musculoskeletal Disease

Pain
Location
Postural relationships
Frequency
Duration
Precipitating or relieving factors
Swelling
Erythema
Warmth
Stiffness
Localized or generalized
Duration
Pattern of involvement
Migratory or additive
Symmetrical or asymmetrical
Muscle weakness

Table 158.2
Sequence of the Rheumatologic Examination

General inspection
Posture
Gait
Symmetry
Upper extremities (include temporomandibular and chest wall articulations)
Spine and pelvis[a]
Lower extremities

[a]May prefer to examine after lower extremities.

Table 158.3
Instruments Required for Rheumatologic Examination

Goniometer (measures joint range of motion in degrees)
Tape measure

Figure 158.1
Palpation of the temporomandibular joints for crepitus, snapping, of instability.

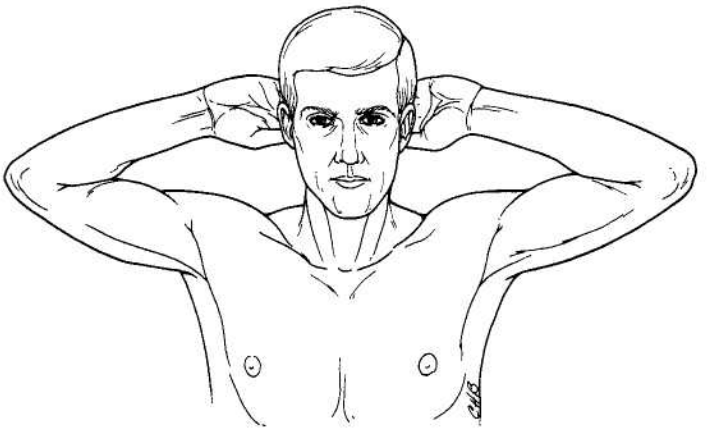

Figure 158.3
Full external rotation of the shoulders.

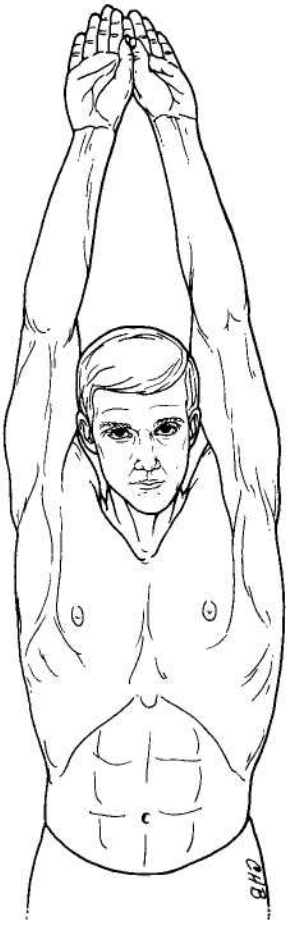

Figure 158.2
Full elevation of the shoulders.

joint by having the patient fully pronate, then fully supinate, both hands.

The *wrists* are next (Figures 158.4, 158.5, and 158.6). Observe and palpate. Ask the patient to press the palms together and elevate the forearms parallel to the floor.

Note the skin temperature as you move from the wrist to the *hands* (Figure 158.7); unless there is joint inflammation, temperature should decrease. Individually observe, palpate, and assess range of motion in the major joints, metacarpophalangeal, proximal interphalangeal, distal interphalangeal. Record grip strength bilaterally (Figure 158.8).

The patient remains seated for examination of the cervical *spine*. Observe for lordosis or kyphosis. Palpate for tenderness. Check flexion by having the patient place the chin on the chest (Figure 158.9), and check extension by having the patient look up at the ceiling as far back as possible (Figure 158.10).

Lateral motion: each ear on shoulder (Figure 158.11).

Rotation: chin on each shoulder (Figure 158.12).

The patient now stands for further evaluation of the spine. Record the normal curvatures. Palpate over the spinous processes and paravertebral muscles. Check range of motion:

- *Flexion:* Keep knees straight while touching floor.
- *Lateral:* Maintain feet together while bending first to one side and then the other.
- *Rotary:* Turn each shoulder as far to side as possible.

The patient now lies down for examination of the lower extremities. The *hip* is examined first. Palpation is of value in the greater trochanter area (the bony prominence at the lateral aspect of the hip region). Tenderness suggests trochanteric bursitis. Then the following maneuvers are carried out on the hip:

- *Abduction:* Fix the pelvis by placing your hand on the side not being tested. Abduct the leg maximally (Figure 158.13).
- *Flexion:* Pelvis is fixed as above. Flex the hip with knee bent (normal, 120 degrees) and then with the knee straight (normal, 90 degrees).

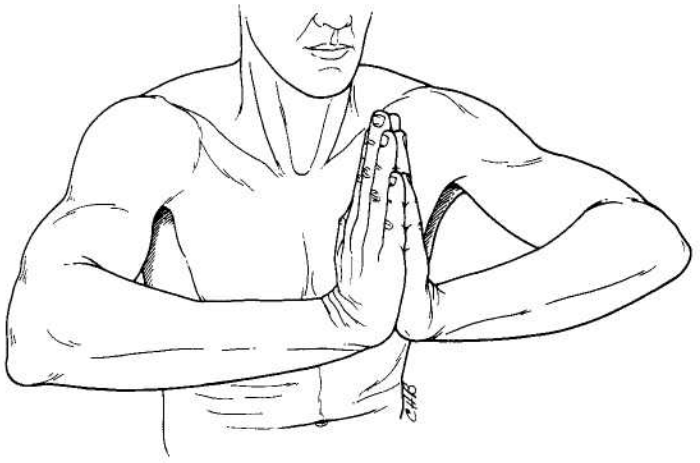

Figure 158.4
Full extension of the wrists.

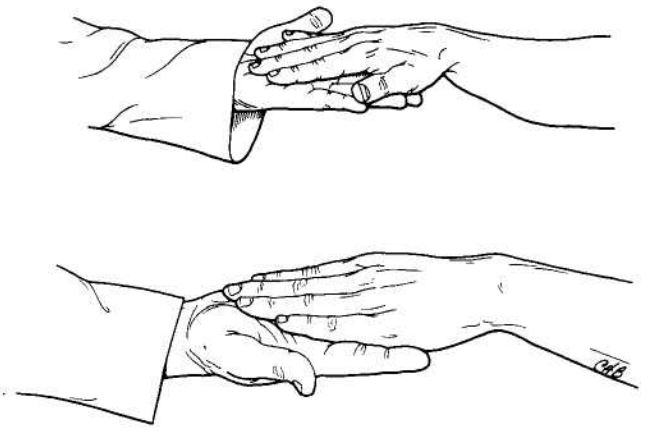

Figure 158.7
Inspection of the hands for erythema, swelling, synovial proliferation, or hypertrophic joint changes.

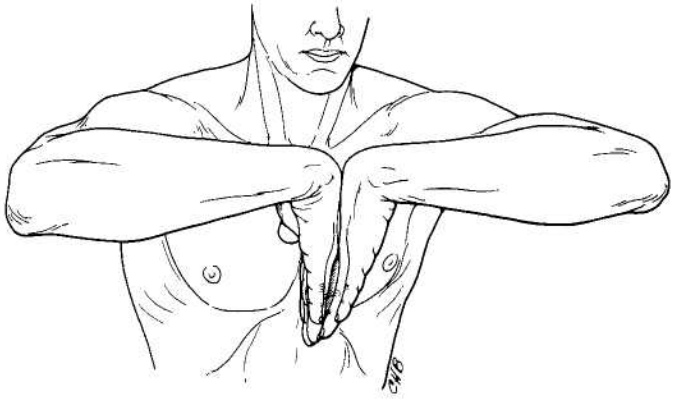

Figure 158.5
Full flexion of the wrists.

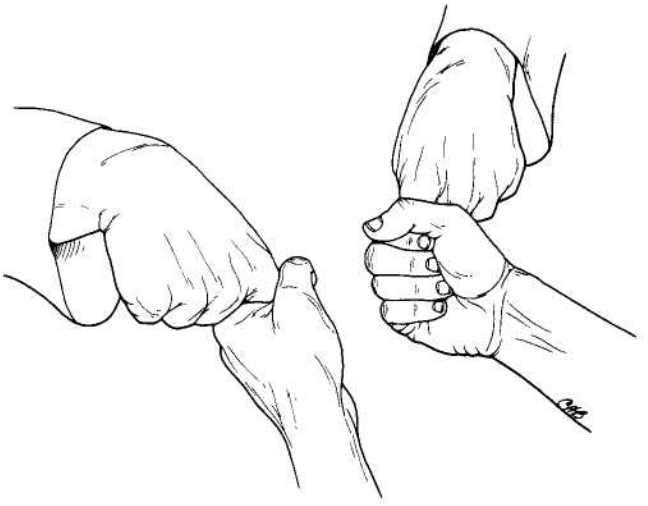

Figure 158.8
Bilateral grip strength is tested by grasping the examiner's index fingers as tightly as possible.

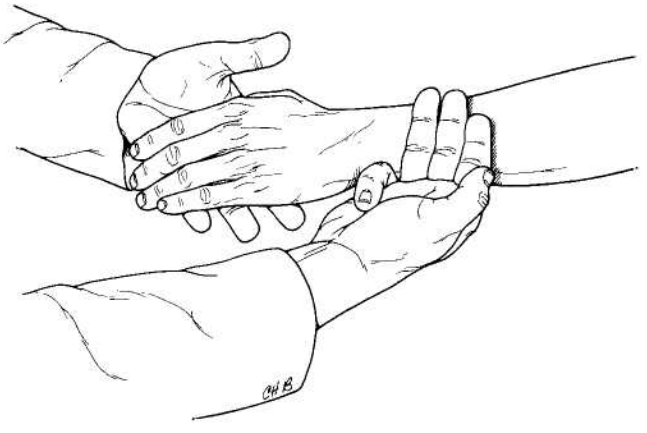

Figure 158.6
Palpation of the wrist for increased skin temperature secondary to inflammation.

Figure 158.9
Full flexion of the cervical spine (neck).

Figure 158.10
Full extension of the cervical spine (neck).

Figure 158.11
Full lateral bending to the right of the cervical spine (neck).

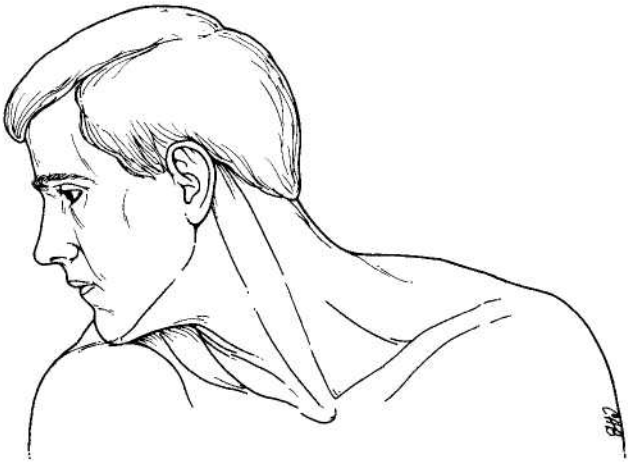

Figure 158.12
Full rotation to the right of the cervical spine (neck).

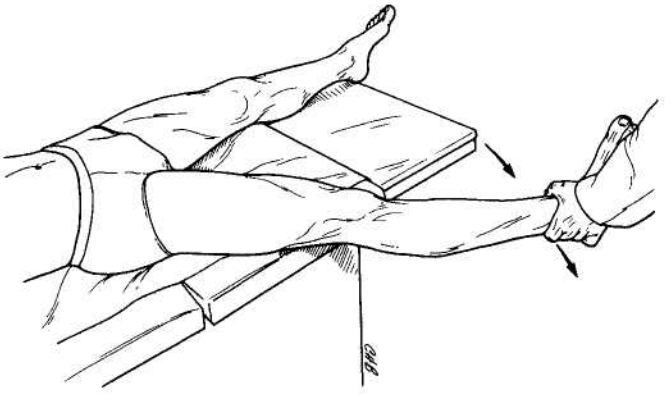

Figure 158.13
Abduction of the right hip.

- *External rotation:* Ask the patient to place the fifth (small) toe on the table (normal, 60 or more degrees).
- *Internal rotation:* Normal is 10 to 15 degrees (Figure 158.14).
- *Flexion contracture:* Opposite knee is flexed until the lumbar lordosis has flattened (Figure 158.15). The hip should be extended fully (flush with examining table), if there is no contracture.
- *Straight leg raising:* As knee is fully extended, the leg is raised and flexed at the hip; this produces stretch on the sciatic nerve. A positive test is pain in the hip or low back with radiation in the sciatic distribution suggestive of nerve root irritation. The angle of elevation of the leg from the table at the point where the pain is produced is recorded (Figure 158.16).
- *Hyperextension:* Patient assumes the prone position and is asked to lift the leg off the table as far as possible without raising the pelvis.

The *knee* examination is next. Inspection is carried out for discoloration, swelling, and deformities, particularly lateral angulation (genu varum) or medial angulation (genu valgum). Note any increased skin temperature or swelling and determine if the swelling is due to synovial proliferation or thickening as opposed to an actual effusion. Then the following maneuvers are carried out on the knee:

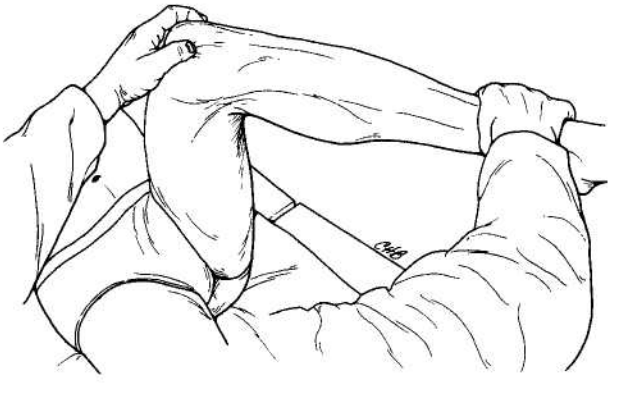

Figure 158.14
Internal rotation of the left hip.

Figure 158.15
Inspection for flexure contracture of the left hip. With pelvis fixed by right hip pulled up in flexion, left leg is extended maximally. The left hip is flush with the table, indicating no contracture.

- *Flexion:* Note the degree of flexion, which should be at least 135 degrees.
- *Extension:* Note any deficit in ability to fully extend to 0 degrees.
- *Ligamentous laxity:* Stretch the medial ligament by placing the palm of the hand on the lateral side of the knee and pulling the leg toward the lateral side of the ankle (Figures 158.17 and 158.18). Correspondingly to stretch the lateral side, place the palm on the medial knee and place the other hand on the lateral ankle and pull toward the examiner. Note any obvious laxity.
- *Cruciates:* Test the stability of anterior and posterior cruciates by holding the femur in a fixed position with the knee flexed at 90 degrees and attempting to pull and push the tibia forward and backward on the femur. Correspondingly forward movement indicates a defect in the anterior cruciate ligament, whereas backward mobility indicates a defect in the posterior cruciate ligament.

The *ankles* are examined next. Observe for discoloration and swelling and palpate for increased tenderness.

Figure 158.16
Full extension and leg raising of the right hip.

Figure 158.17
Testing medial collateral ligament stability of the right knee. Note counterpressure of ankle laterally stressed as knee is medially stressed.

- *Dorsiflexion:* The patient is asked to pull the toes up toward the knee (Figure 158.19).
- *Plantar flexion:* Ask the patient to push the feet down as far as they can go (Figure 158.19).

Lastly the *feet* are inspected for abnormal coloration and localized areas of swelling. Look for obvious abnormalities in the longitudinal arch, including a falling of the arch, so-called pes planus or flat foot, or an abnormal elevation of the arch, so-called pes cavus. The first metatarsophalangeal joints are observed for lateral angulation, so-called hallux valgus. The other toes are examined for hammer toe or cock-up deformities, and the metatarsal heads are observed on the plantar surface for formation of callosities over pres-

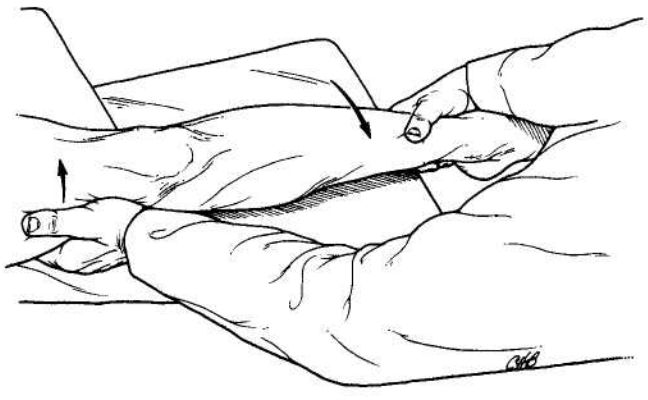

Figure 158.18
Testing lateral collateral ligament stability of the left knee. Note counterpressure of ankle medially as knee is laterally stressed.

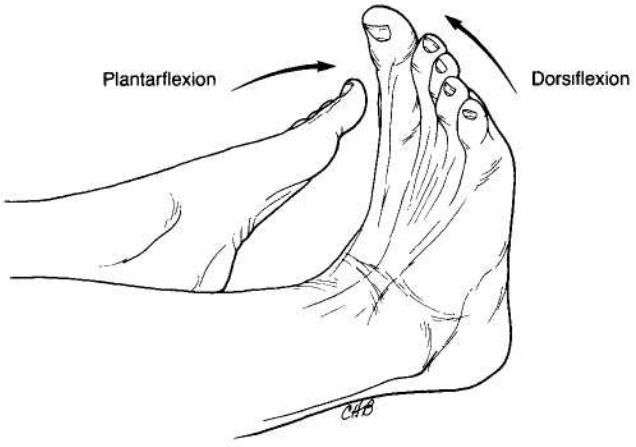

Figure 158.19
Full plantar and dorsiflexion of the ankles.

Figure 158.20
Palpation of individual interphalangeal joints of the toes for signs of synovial inflammation and restricted joint range of motion.

Figure 158.21
Examination of the tarsal joints (midfoot) for eversion (away from the midline) and inversion (toward the midline).

sure points. Palpate each phalangeal and each metacarpophalangeal joint (Figure 158.20).

- *Flexion:* All toes are actively and passively flexed to their maximum, observing for decreased mobility or evidence of crepitus.
- *Extension:* The aforementioned small joints of the toes are checked for ability to extend fully.
- *Eversion and inversion:* Eversion and inversion are primarily a function of the subtalar and tarsal joints, which after checking will complete the peripheral joint examination (Figure 158.21).